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AUTHOR Nichols, Paul L.
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ABSTRACT

Examined with over 28,000 7-year-old children whose mothers registered for prenatal care was the relationship between perinatal complications and such characteristics as poor school achievement, hyperactivity, and neurological soft signs associated with the diagnosis of minimal brain dysfunction (MBD). Ten perinatal antecedents were studied: toxemia, fever, cigarette smoking during pregnancy, placental complications, use of mid forceps, breech delivery, low birthweight, diagnoses of neonatal brain abnormality and dysmaturity, and significant respiratory events. (Tables provide statistical data regarding the frequencies of MBD symptoms with each of the above perinatal conditions.) (SBH)

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Minimal Brain Dysfunction: Associations with Perinatal Complications

Paul L. Nichols

National Institute of Neurological and Communicative Disorders and Stroke

Perinatal complications have been implicated in the etiology of poor school achievement, hyperactivity, and neurological soft signs, all characteristics of children often given the controversial diagnosis of minimal brain dysfunction. In this report, these characteristics are examined for associations with 10 perinatal antecedents: toxemia, fever, and cigarette smoking during pregnancy, placental complications, use of mid forceps, breech delivery, low birthweight, diagnoses of neonatal brain abnormality and dysmaturity, and significant respiratory events.

The sample consisted of over 28,000 white and black children whose mothers registered for prenatal care in the NINCDS Collaborative Perinatal Project (NCPP). Identification of affected children was based on comprehensive psychological and neurological examinations given all NCPP children at age 7 (Nichols, Chen, & Pomeroy, 1976). Briefly, symptoms from these examinations were subjected to factor analysis. Three emerging factors represented achievement (from achievement test-IQ discrepancy), hyperactivity (from behavioral ratings), and neurological signs. Scores for each factor were assigned to each child. Arbitrary cutoff points on the distributions of factor scores for the entire NCPP population indicated that approximately 8% of the current study sample were low achievers, 8% were hyperactive, and 8% had neurological soft signs. The frequency of

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affected children for each of the factors was determined for different categories of the antecedent variables, and compared to the frequency expected among children of the same sex, race, and study hospital. The significance of the differences between observed and expected numbers of affected children was computed using the χ^2 statistic.

Abnormal scores for all three factors were related to the number of cigarettes smoked by the mother during pregnancy. Children of mothers who smoked two or more packs per day had a 30-60% increase over the expected frequency of abnormal scores. The significance levels for low achievement, hyperactivity, and neurological signs were .01, .001, and .05, respectively. In addition, low achievement ($p < .01$) and hyperactivity ($p < .001$) were more frequent than expected among children of mothers who smoked between one and two packs of cigarettes per day during pregnancy.

Among toxemia categories, defined in the NCPP population by Friedman (1976), MBD symptoms were not increased among children of mothers who had hypertension alone or with mild proteinuria during pregnancy. Severe proteinuria was associated with a small but significant increase in hyperactivity ($p < .05$). Also, hypotension during pregnancy (a diastolic reading of 65 or lower) was associated with an increase in low achievement ($p < .05$).

Fever, the final pregnancy variable examined, was not significantly related to any MBD symptom, although an increase in the frequency of hyperactivity nearly reached the .05 level.

Among the three labor and delivery variables, the use of midforceps was associated with a slight increase in the frequency of neurological signs ($p < .01$). An unexpected decrease in the frequency of low achievement in children born with midforceps assisted deliveries noted in preliminary results was no longer significant when the expected frequency took into consideration the study hospital of the affected children.

Hyperactivity was more frequent among breech delivered children ($p < .05$). However, placental complications (abruptio placenta, marginal sinus rupture, or placenta previa) were not related to any of the three factor scores.

In the neonatal period, birthweights below 2000 grams were associated with a 40-50% increase in the frequency of all three abnormal scores ($p < .05, .001, .01$); values between 2000 and 2500 grams were also associated with an increase in all abnormal scores ($p < .05, .001, .01$). After combining these two groups, all abnormal scores were significantly associated with birthweight below 2500 grams at the .001 level. Children with optimal birthweights (3500-4000 grams) were examined to see if they were at lower risk than expected for the MBD signs. It was found that both low achievement and hyperactivity were less frequent than expected among this group ($p < .01$).

A definite diagnosis of neonatal brain abnormality (based on hypertonia, hypotonia, hyperactivity, abnormal reflexes, and other signs) was rare and associated with mental retardation. However, a

suspect diagnosis was more common (up to 10% in this cohort) and was associated with an increase in abnormal neurological factor scores ($p < .01$). The associations noted earlier of brain abnormality diagnoses with low achievement and hyperactivity were found to be due to the differences in frequency of the diagnosis among the study hospitals.

Neither respiratory problems (apneic episodes, resuscitation) nor dysmaturity (signs of malnutrition, meconium staining, or prolonged gestation) was associated with any abnormal factor score. In fact, low achievement occurred less frequently than expected among dysmature white boys.

Note that while the associations described in this report were statistically significant, often at the .001 level, the predictive power of the antecedents was not great. For example, while increased frequencies of all three abnormal factor scores were associated with low birthweight, most of the children with low birthweight were not affected, and most of the affected children did not have low birthweights.

It should also be emphasized that these analyses were essentially univariate. More detailed multivariate studies are anticipated, in which the combined ability of these and other variables to predict individual and multiple signs of minimal brain dysfunction will be explored.

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FREQUENCIES OF MBD SYMPTOMS IN HIGH RISK CHILDREN

Pregnancy Condition: Maternal Smoking (2+ packs/day)

	N	Low Achievement			Hyperactivity			Neurological Signs		
		Obs.	Exp.	p	Obs.	Exp.	p	Obs.	Exp.	p
White males	198	30	21.0	.05	27	20.3	–	31	25.1	–
White females	178	14	8.4	–	17	11.2	–	20	13.3	–
Black males	40	5	4.7	–	8	3.3	.05	1	2.5	–
Black females	31	3	2.0	–	5	2.2	–	4	1.2	–
Total	447	52	36.1	.01	57	37.0	.001	56	42.1	.05

FREQUENCIES OF MBD SYMPTOMS IN HIGH RISK CHILDREN

Pregnancy Condition: Maternal Smoking (1-2 packs/day)

	N	Low Achievement			Hyperactivity			Neurological Signs		
		Obs.	Exp.	p	Obs.	Exp.	p	Obs.	Exp.	p
White males	1,656	197	161.7	.01	201	173.0	.05	230	215.7	–
White females	1,558	79	73.4	–	115	100.4	–	127	113.8	–
Black males	436	58	57.6	–	46	36.7	–	36	33.5	–
Black females	482	38	30.1	–	41	33.8	–	23	19.4	–
Total	4,132	372	322.8	.01	403	343.9	.001	416	382.4	–

FREQUENCIES OF MBD SYMPTOMS IN HIGH RISK CHILDREN

Pregnancy Condition: Maternal Smoking (1+ packs/day)

	N	Low Achievement			Hyperactivity			Neurological Signs		
		Obs.	Exp.	p	Obs.	Exp.	p	Obs.	Exp.	p
White males	1,854	227	182.7	.001	228	193.3	.01	261	240.8	–
White females	1,736	93	81.8	–	132	111.6	–	147	127.1	–
Black males	476	63	62.3	–	54	40.0	.01	37	36.0	–
Black females	513	41	32.1	–	46	36.0	–	27	20.6	–
Total	4,579	424	358.9	.001	460	380.9	.001	472	424.5	.05

FREQUENCIES OF MBD SYMPTOMS IN HIGH RISK CHILDREN

Pregnancy Condition: Hypertension (DBP ⩾95)

	N	Low Achievement			Hyperactivity			Neurological Signs		
		Obs.	Exp.	p	Obs.	Exp.	p	Obs.	Exp.	p
White males	399	30	32.3	–	35	41.8	–	54	55.6	–
White females	346	14	12.9	–	19	21.5	–	24	27.6	–
Black males	259	40	33.3	–	29	21.8	–	20	17.9	–
Black females	285	20	17.1	–	22	18.8	–	14	10.3	–
Total	1,289	104	95.6	–	105	103.9	–	112	111.4	–

FREQUENCIES OF MBD SYMPTOMS IN HIGH RISK CHILDREN

Pregnancy Condition: Hypertension (DBP ⩾85) and Proteinuria (⩾1+)

	N	Low Achievement			Hyperactivity			Neurological Signs		
		Obs.	Exp.	p	Obs.	Exp.	p	Obs.	Exp.	p
White males	231	22	27.2	–	27	24.0	–	29	28.5	–
White females	203	12	12.4	–	15	14.1	–	17	13.9	–
Black males	200	25	26.9	–	12	18.2	–	16	17.0	–
Black females	247	16	15.2	–	19	17.4	–	15	10.0	–
Total	881	75	81.7	–	73	73.7	–	77	69.4	–

FREQUENCIES OF MBD SYMPTOMS IN HIGH RISK CHILDREN

Pregnancy Condition: Proteinuria (⩾2+)

	N	Low Achievement			Hyperactivity			Neurological Signs		
		Obs.	Exp.	p	Obs.	Exp.	p	Obs.	Exp.	p
White males	52	6	6.1	–	6	5.4	–	9	6.5	–
White females	59	4	4.2	–	9	4.2	–	2	3.8	–
Black males	115	19	15.3	–	11	9.3	–	5	7.9	–
Black females	139	4	9.3	–	12	8.6	–	9	6.2	–
Total	365	33	34.9	–	38	27.5	.05	25	24.4	–

FREQUENCIES OF MBD SYMPTOMS IN HIGH RISK CHILDREN

Pregnancy Condition: Low Blood Pressure (DBP ≤ 65)

	N	Low Achievement			Hyperactivity			Neurological Signs		
		Obs.	Exp.	p	Obs.	Exp.	p	Obs.	Exp.	p
White males	152	25	19.9	–	9	15.9	–	15	15.9	–
White females	156	15	10.4	–	13	10.6	–	10	8.0	–
Black males	380	60	46.9	.05	24	28.0	–	20	20.5	–
Black females	375	22	22.2	–	24	24.0	–	15	10.2	–
Total	1,063	122	99.4	.05	70	78.5	–	60	54.6	–

FREQUENCIES OF MBD SYMPTOMS IN HIGH RISK CHILDREN

Pregnancy Condition: Fever

	N	Low Achievement			Hyperactivity			Neurological Signs		
		Obs.	Exp.	p	Obs.	Exp.	p	Obs.	Exp.	p
White males	1,743	194	176.5	–	196	181.6	–	219	219.9	–
White females	1,669	74	81.2	–	108	108.5	–	126	116.1	–
Black males	1,495	205	198.3	–	133	122.4	–	119	105.7	–
Black females	1,613	117	103.1	–	119	104.7	–	55	60.2	–
Total	6,520	590	559.1	–	556	517.2	–	519	501.9	–

FREQUENCIES OF MBD SYMPTOMS IN HIGH RISK CHILDREN

Delivery Condition: Midforceps

	N	Low Achievement			Hyperactivity			Neurological Signs		
		Obs.	Exp.	p	Obs.	Exp.	p	Obs.	Exp.	p
White males	993	58	73.8	–	111	103.4	–	152	124.2	.01
White females	848	31	29.0	–	52	50.9	–	63	54.8	–
Black males	338	36	42.2	–	35	29.5	–	30	23.5	–
Black females	342	17	20.8	–	25	23.0	–	15	12.0	–
Total	2,521	142	165.8	–	223	206.8	–	260	214.5	.01

FREQUENCIES OF MBD SYMPTOMS IN HIGH RISK CHILDREN

Delivery Condition: Breech

	N	Low Achievement			Hyperactivity			Neurological Signs		
		Obs.	Exp.	p	Obs.	Exp.	p	Obs.	Exp.	p
White males	235	28	23.0	–	26	24.1	–	29	29.9	–
White females	264	10	12.9	–	26	17.0	–	17	18.5	–
Black males	132	20	17.6	–	14	9.8	–	8	9.1	–
Black females	192	9	12.2	–	16	12.4	–	10	8.0	–
Total	823	67	65.7	–	82	63.3	.05	64	65.5	–

FREQUENCIES OF MBD SYMPTOMS IN HIGH RISK CHILDREN

Delivery Condition: Placental Complications

	N	Low Achievement			Hyperactivity			Neurological Signs		
		Obs.	Exp.	p	Obs.	Exp.	p	Obs.	Exp.	p
White males	288	24	23.4	–	29	29.5	–	45	36.0	–
White females	284	11	10.1	–	23	17.1	–	18	19.0	–
Black males	204	36	26.8	–	19	17.0	–	13	14.6	–
Black females	198	10	12.7	–	20	13.5	–	6	7.3	–
Total	974	81	73.0	–	91	77.1	–	82	76.9	–

FREQUENCIES OF MBD SYMPTOMS IN HIGH RISK CHILDREN

Neonatal Condition: Birthweight Under 2000 g.

	N	Low Achievement			Hyperactivity			Neurological Signs		
		Obs.	Exp.	p	Obs.	Exp.	p	Obs.	Exp.	p
White males	85	9	9.1	–	14	8.8	–	17	11.2	–
White females	106	16	5.6	.001	11	6.8	–	11	7.6	–
Black males	164	25	22.0	–	21	13.4	.05	16	13.0	–
Black females	225	18	14.0	–	19	14.7	–	18	8.0	.001
Total	580	68	50.7	.05	65	43.7	.001	62	39.8	.001

FREQUENCIES OF MBD SYMPTOMS IN HIGH RISK CHILDREN

Neonatal Condition: Birthweight 2001-2500 g.

	N	Low Achievement			Hyperactivity			Neurological Signs		
		Obs.	Exp.	p	Obs.	Exp.	p	Obs.	Exp.	p
White males	320	36	32.4	–	49	32.8	.01	48	40.9	–
White females	486	29	23.1	–	35	31.2	–	48	34.8	.05
Black males	545	93	71.7	.01	55	44.0	–	43	40.1	–
Black females	777	54	49.0	–	66	50.8	.05	39	29.4	–
Total	2,128	212	176.2	.01	205	158.8	.001	178	145.2	.01

FREQUENCIES OF MBD SYMPTOMS IN HIGH RISK CHILDREN

Neonatal Condition: Birthweight Under 2500 g.

	N	Low Achievement			Hyperactivity			Neurological Signs		
		Obs.	Exp.	p	Obs.	Exp.	p	Obs.	Exp.	p
White males	405	45	41.5	–	63	41.6	.001	65	52.1	–
White females	592	45	28.7	.01	46	38.0	–	59	42.4	.05
Black males	709	118	93.7	.01	76	57.4	.05	59	53.1	–
Black females	1,002	72	63.0	–	85	65.5	.05	57	37.4	.001
Total	2,708	280	226.9	.001	270	202.5	.001	240	185.0	.001

FREQUENCIES OF MBD SYMPTOMS IN LOW RISK CHILDREN

Neonatal Condition: Birthweight 3501-4000 g.

	N	Low Achievement			Hyperactivity			Neurological Signs		
		Obs.	Exp.	p	Obs.	Exp.	p	Obs.	Exp.	p
White males	2,343	199	222.8	–	223	243.1	–	319	305.2	–
White females	1,739	61	79.3	.05	90	111.8	.05	100	111.8	–
Black males	1,306	162	171.9	–	92	108.6	–	97	95.3	–
Black females	946	48	58.6	–	44	64.4	.05	29	37.3	–
Total	6,334	470	532.6	.01	449	527.9	.01	545	549.6	–

FREQUENCIES OF MBD SYMPTOMS IN HIGH RISK CHILDREN

Neonatal Condition: Suspected Brain Abnormality

	N	Low Achievement			Hyperactivity			Neurological Signs		
		Obs.	Exp.	p	Obs.	Exp.	p	Obs.	Exp.	p
White males	780	93	102.0	–	98	77.7	.05	81	70.7	–
White females	600	48	39.9	–	45	37.9	–	39	28.5	–
Black males	744	104	112.2	–	65	73.2	–	83	66.6	.05
Black females	618	57	48.4	–	47	44.5	–	33	31.0	–
Total	2,742	302	302.5	–	255	233.3	–	236	196.8	.01

FREQUENCIES OF MBD SYMPTOMS IN HIGH RISK CHILDREN

Neonatal Condition: Respiratory Events

	N	Low Achievement			Hyperactivity			Neurological Signs		
		Obs.	Exp.	p	Obs.	Exp.	p	Obs.	Exp.	p
White males	590	64	54.6	–	69	61.7	–	82	75.4	–
White females	419	22	17.5	–	32	26.4	–	35	30.6	–
Black males	453	51	58.8	–	49	39.4	–	32	35.1	–
Black females	434	30	27.1	–	31	30.8	–	25	18.1	–
Total	1,896	167	158.0	–	181	158.3	–	174	159.2	–

FREQUENCIES OF MBD SYMPTOMS IN HIGH RISK CHILDREN

Neonatal Condition: Dysmaturity

	N	Low Achievement			Hyperactivity			Neurological Signs		
		Obs.	Exp.	p	Obs.	Exp.	p	Obs.	Exp.	p
White males	1,517	102	132.9	.01	167	160.7	–	191	201.9	–
White females	1,192	57	52.0	–	84	76.3	–	83	90.2	–
Black males	1,032	130	141.9	–	103	100.2	–	110	98.1	–
Black females	922	63	62.0	–	83	71.0	–	60	50.0	–
Total	4,663	352	388.0	–	437	408.0	–	444	440.2	–